NEWS **SCIENCE** NEWS

THE ELECTRIC SUN & THE MYTH OF THE NUCLEAR FURNACE

by David Talbott

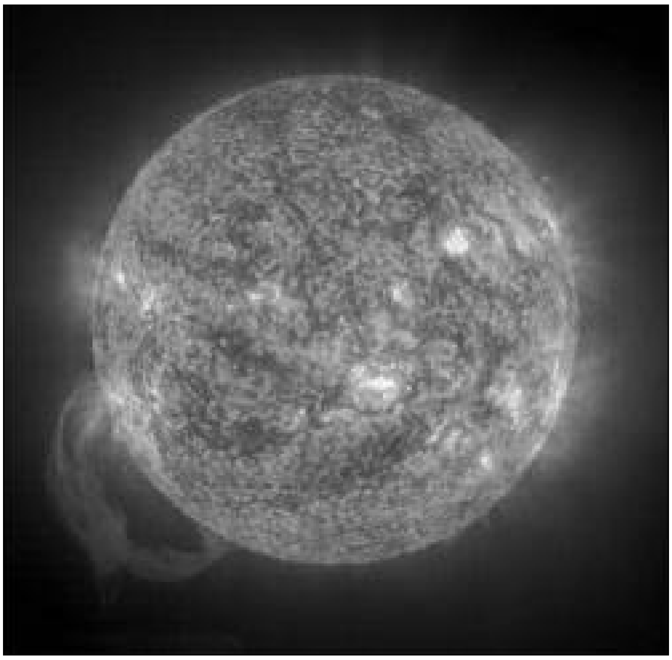
What is the source of the Sun's light and heat? Throughout history, people have proposed answers to this question that have always reflected human experience. The Sun was a shining god, or a "spark" cast off in the creation. Later it was a pile of burning sticks or coal.

By the 19th century, astronomers had become accustomed to thinking that gravity was the dominant force in the heavens. So they began to conjecture that the energy of the Sun might be due to "gravitational collapse", a compression of solar gases by gravity. This simple hypothesis, its proponents claimed, could provide the required energy output for a few tens of millions of years. However, by the late 19th century, geologists were confident that Earth was much older than the astronomers' model would allow, and the conflict between astronomy and geology continued for several decades.

Then, in 1920, the British astronomer Sir Arthur Eddington combined the principle of gravitational collapse with an exciting new principle in the physical sciences: nuclear fusion. He proposed that at the core of the Sun, pressures and temperatures induced a nuclear reaction fusing hydrogen into helium.

In 1939, two astrophysicists, Subrahmanyan Chandrasekhar and Hans Bethe, working independently, began to quantify the gravitational collapse and nuclear fusion hypothesis. Bethe described the results of his calculations in a brief paper entitled "Energy Production in Stars", published in 1939.

The model that followed the work of Eddington, Chandrasekhar and Bethe described a "nuclear furnace" responsible for igniting stars. And for decades now, cosmologists, astronomers and astrophysicists have accepted the basic concept as fact. In the early formulations of this "standard model" of star formation, it was said that the gravitational force within a primordial cloud leads to its progressive compression into a "circumstellar disc", as the outer material in the cloud "falls" inward and gravity gives birth to a star-sized sphere whose core temperature continues to rise under increasing pressures. Collisions of atoms within the core eventually become so energetic that electrons are stripped from their nuclei, leaving free electrons and hydrogen protons (a plasma, as we now understand it). In stars roughly comparable to our Sun, with envisioned core temperatures less than 15 million Kelvin, the nuclear reaction begins when hydrogen protons are joined or stuck together in the "proton-proton fusion" of hydrogen into helium.



Credit: NASA/CXC/SAO

Critics, however, pointed out that the temperatures given by standard gas laws are not sufficient to provoke nuclear fusion. They cited the "Coulomb barrier", in this case the electric repulsion between two protons or like charges. Once protons are fused, they could be held together by the strong nuclear force, but that force dominates only at short distances. To achieve fusion, it would be necessary for protons to cross the barrier of the repulsive electric force, which is sufficient to keep the protons apart forever. But Eddington's successors accomplished the impossible by something called "quantum tunnelling", enabling an extremely small percentage of protons simply to "appear" inside the barrier at any particular time.

It is ironic that the early objections to the fusion model of the Sun focused on the powerful electric force. This was long before the arrival of the Space Age, with its discovery that the charged particles of plasma permeate interplanetary and interstellar space, and long before any systematic investigations of plasma and electricity in space.

Advocates of the "nuclear furnace" model made a series of fundamental assumptions common to astronomy long before the emergence of a nuclear model of the Sun. The credibility of these assumptions was not an issue to them. They assumed that diffuse clouds of gas in space would collapse gravitationally into star-sized bodies. They assumed that the Sun's mass could be calculated simply from the orbital motions of the planets. They assumed that Newtonian calculations of mass, coupled with standard gas laws, enabled them to determine the pressure and temperature of the Sun's core. The pioneers of the nuclear furnace model also followed another assumption common to astronomy in their time: that the Sun and planets are electrically neutral. They gave no consideration to the role of electricity and no consideration to the role of the magnetic fields that electric currents generate.

Are the assumptions made in the first

half of the 20th century still warranted after decades of space exploration? Those proposing an electrical perspective, based on more recent data, insist that the earlier conjectures are not only unwarranted but discredited by direct observation and measurement. They emphasise that every feature of the Sun, as we now observe it, defies both the gravitational assumptions and the standard gas laws relating to pressure, density, temperature and relative motions of gases. The deepest observable surface of the Sun yields a temperature of about 6,000 degrees Kelvin. As we peer into the darker interior of sunspots we see cooler regions, not hotter. But moving outward to the bottom of the corona, the temperature jumps spectacularly to almost two million degrees. Thus, the superheated shell of the Sun's corona reverses the expected temperature gradient predicted by models of internal heating.

It seems that the Sun does not even "respect" gravity. The mass of charged particles—expelled by the Sun as the solar wind—continues to accelerate beyond Mercury, Venus and Earth. Solar prominences and coronal mass ejections do not obey gravity, either. Nor does sunspot migration. Nor does the movement of the atmosphere, since the upper layers rotate faster than the lower—reversing the situation predicted by theory—while the equatorial atmosphere completes its rotation more rapidly than the atmosphere at higher latitudes—another reversal of predicted motions. If the Sun's atmosphere were subject only to gravity and the hot surface, it should be only a few thousand kilometres thick instead of the hundred thousand kilometres or more that we measure.

Even the shape of the Sun defies the expectations of theory. The revolving Sun should be an oblate sphere. But it is virtually a perfect sphere, as if gravity and inertia have been overruled by something else.

For the electrical theorists, the "something else" should be obvious from the dominant, observed features of the Sun (in contrast to things assumed but never seen).

The anomalies facing the standard model of the Sun are predictable features of a glow discharge. Refer to Pictures of the Day at http://www.thunderbolts.info..

[Note: This article, dated 27 May 2005, is copyright © 2005 Thunderbolts.info. The full text of this article, with text links, can be viewed at http://www.thunderbolts.info/tpod/2005/arch05/050517fusion.htm.]

THE ELECTRIC GLOW OF THE SUN

by David Talbott

A little known fact: popular ideas about the Sun have not fared well under the tests of a scientific theory. The formulators of the standard Sun model worked with gravity, gas laws and nuclear fusion. But closer observation of the Sun has shown that electrical and magnetic properties dominate solar behaviour.

For centuries, the nature of the Sun's radiance remained a mystery to astronomers. The Sun is the only object in the solar system that produces its own visible light. All others reflect the light of the Sun. What unique trait of the Sun enables it to shine upon the other objects in the solar system?

Today, astronomers assure us that the most fundamental question has now been answered. The Sun is a thermonuclear furnace. The ball of gas is so large that astronomers envision pressures and densities within its core sufficient to generate temperatures of about 16 million K, producing a continuous "controlled" nuclear reaction.

Most astronomers and astrophysicists investigating the Sun are so convinced of the fusion model that only the rarest among them will countenance challenges to the underlying idea. Standard textbooks and institutional research, complemented by a chorus of scientific and popular media, "ratify" the fusion model of the Sun year after year by ignoring evidence to the contrary.

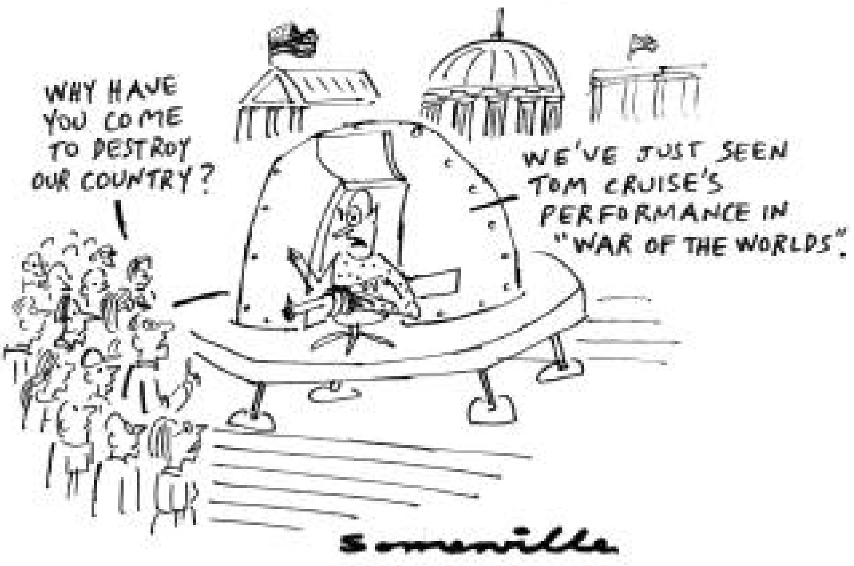
A growing group of independent researchers, however, insists that the popular idea is incorrect. These researchers say that the Sun is *electric*. It is a glow discharge fed by galactic currents. And they emphasise that the fusion model anticipated none of the milestone discoveries about the Sun, while the electric model predicts and explains the very observations that posed the greatest quandaries for solar investigation.

More than 60 years ago, Dr Charles E. R. Bruce, of the Electrical Research Association in England, offered a new perspective on the Sun. An electrical researcher, astronomer and expert on the effects of lightning, Bruce proposed in 1944 that the Sun's "photosphere has the appearance, the temperature and the spectrum of an electric arc; it has arc characteristics because it is an electric arc, or a large number of arcs in parallel". This discharge characteristic, he claimed, "accounts for the observed granulation of the solar surface".

Bruce's model, however, was based on a conventional understanding of atmospheric lightning, allowing him to envision the "electric" Sun without reference to external electric fields.

Plasma Glow Discharge

Years later, a brilliant engineer, Ralph Juergens, inspired by Bruce's work, added a revolutionary possibility. In a series of articles beginning in 1972, Juergens suggested that the Sun is not an electrically isolated body in space but the most positively charged object in the solar system, the centre of a radial electric field. This



field, he said, lies within a larger galactic field. With this hypothesis, Juergens became the first to make the theoretical leap to an external power source of the Sun.

Juergens proposed that the Sun is the focus of a "coronal glow discharge" fed by galactic currents. To avoid misunderstanding of this concept, it is essential that we distinguish the complex electrodynamic glow discharge model of the Sun from a simple electrostatic model that can be easily dismissed.

Throughout most of the volume of a glow discharge, the plasma is nearly neutral with almost equal numbers of protons and electrons. In this view, the charge differential at the Earth's distance from the Sun is smaller than our present ability to measure—perhaps one or two electrons per cubic metre.

But the charge density is far higher closer to the Sun, and at the solar corona and surface the electric field is of sufficient strength to generate all of the energetic phenomena we observe.

Today, the electric theorists Wallace Thornhill and Donald Scott urge a critical comparison of the fusion model and the electrical model. Given what we now know about the Sun, which model meets the tests of unity, coherence, simplicity and predictability? Why did so many discoveries surprise investigators and even contradict the expectations of the fusion model? Is there any fundamental feature of the Sun that contradicts the glow discharge hypothesis?

Our closer looks at the Sun have revealed the pervasive influence of magnetic fields, which are the effect of electric currents. Sunspots, prominences, coronal mass ejections and a host of other features require ever more complicated guesswork on behalf of the fusion model. But this is the way an anode in a coronal glow discharge behaves!

In the electric model, the Sun is the "anode" or positively charged body in the electrical exchange, while the "cathode" or negatively charged contributor is not a discrete object but the invisible "virtual cathode" at the limit of the Sun's coronal discharge. (Coronal discharges can sometimes be seen as a glow surrounding high-voltage transmission wires, where the wires discharge into the surrounding air). This virtual cathode lies far beyond the planets. In the lexicon of astronomy, this is the "heliopause". In electrical terms, it is the cellular sheath or "double layer" separating the plasma cell that surrounds the Sun ("heliosphere") from the enveloping galactic plasma.

In an electric universe, such cellular forms are expected between regions of dissimilar plasma properties. According to the glow discharge model of the Sun, almost the entire voltage difference between the Sun and its galactic environment occurs across the thin boundary sheath of the heliopause.

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Inside the heliopause there is a weak but constant radial electrical field centred on the Sun. A weak electric field, immeasurable locally with today's instruments but cumulative across the vast volume of space within the heliosphere, is sufficient to power the solar discharge.

The visible component of a coronal glow discharge occurs above the anode, often in layers. The Sun's red chromosphere is part of this discharge. (Unconsciously, it seems, the correct electrical engineering term was applied to the Sun's corona.) Correspondingly, the highest particle energies are not at the photosphere but above it.

Solar Temperatures

The electric theorists see the Sun as a perfect example of this characteristic of glow discharges—a radical contrast to the expected dissipation of energy from the core outward in the fusion model of the Sun.

At about 500 kilometres (310 miles) above the photosphere or visible surface, we find the coldest measurable temperature, about 4,400 degrees K. Moving upward, the temperature then rises steadily to about 20,000 degrees K at the top of the chromosphere, some 2,200 kilometres (1,200 miles) above the Sun's surface. Here it abruptly jumps hundreds of thousands of degrees, then continues slowly rising, eventually reaching two million degrees in the corona. Even at a distance of one or two solar diameters, ionised oxygen atoms reach a temperature of 200 million degrees!

In other words the "reverse temperature gradient", while meeting the tests of the glow discharge model, contradicts every original expectation of the fusion model.

But this is only the first of many enigmas and contradictions facing the fusion hypothesis. As astronomer Fred Hoyle pointed out years ago, with the strong gravity and the mere 5,800-degree temperature at the surface, the Sun's atmosphere should be only a few thousand kilometres thick, according to the "gas laws" that astrophysicists typically apply to such bodies. Instead, the atmosphere balloons out to 100,000 kilometres, where it heats up to a million degrees or more. From there, particles accelerate out among the planets in defiance of gravity. Thus the planets, Earth included, could be said to orbit inside the Sun's diffuse atmosphere.

The discovery that blasts of particles escape the Sun at an estimated 400–700 kilometres per second came as an uncomfortable surprise for advocates of the nuclear-powered model. Certainly, the "pressure" of sunlight cannot explain the acceleration of the solar "wind". In an electrically neutral, gravity-driven universe, particles are not hot enough to escape such massive bodies, which (in the theory) are attractors only. And yet, the particles of the solar wind continue to accelerate past Venus, Earth and Mars. Since these particles are not miniature "rocket ships", this acceleration is the last thing one should expect!

According to the electric theorists, a weak electric field, focused on the Sun, better explains the acceleration of the charged particles of the solar wind. Electric fields accelerate charged particles. And just as magnetic fields are undeniable witnesses to the presence of electric currents, particle acceleration is a good measure of the strength of an electric field.

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DOES THE EARTH HAVE A SOLAR UMBILICAL CORD?

January 2005 was a stormy month—in space. With little warning, a giant spot materialised on the Sun and started exploding. Between 15 and 19 January, sunspot 720 produced four powerful solar flares. When it exploded a fifth time on 20 January, onlookers were not surprised.

They should have been. Researchers realise now that the 20 January blast was something special. It has shaken the foundations of space weather theory and possibly changed the way astronauts are going to operate when they return to the Moon.

Scant minutes after the 20 January flare, a swarm of high-speed protons surrounded Earth and the Moon. Thirty minutes later, the most intense proton storm in decades was underway.

"We've been hit by strong proton storms before, but [never so quickly]," says solar physicist Robert Lin of UC Berkeley. "Proton storms normally develop hours or even days after a flare."

This one began in minutes.

Proton storms cause all kinds of problems. They interfere with ham radio communications. They zap satellites, causing short circuits and computer reboots. Worst of all, they can penetrate the skin of spacesuits and make astronauts feel sick.

"An astronaut on the Moon, caught outdoors on January 20, would have had almost no time to dash for shelter," says Lin. The storm came fast and "hard", with proton energies exceeding 100 million electron volts. These are the kind of high-energy particles that can do damage to human cells and tissue.

"The last time we saw a storm like this was in February 1956." The details of that event are uncertain, though, because it happened before the Space Age. "There were no satellites watching the Sun."

According to space weather theory (soon to be revised), this is how a proton storm develops. It begins with an explosion, usually above a sunspot. Sunspots are places where strong magnetic fields poke through the surface of the Sun. For reasons no one completely understands, these fields can become unstable and explode, unleashing as much energy as 10 billion hydrogen bombs.

From Earth we see a flash of light and X-rays. This is the "solar flare", and it's the first sign that an explosion has occurred. Light from the flare reaches Earth in only eight minutes.

Next, if the explosion is powerful enough, a billion-ton cloud of gas billows away from the blast site. This is the coronal mass ejection (CME). CMEs are relatively slow. Even the fastest ones, travelling at 1,000 to 2,000 km/s, take a day or so to reach Earth. You know a CME has just arrived when you see auroras in the sky.

En route to Earth, CMEs plough through a lot of gaseous material, first in the Sun's atmosphere and then out in interplanetary space. You thought space was empty? No. The void between planets is filled with protons and other particles from the solar wind. Shock waves in front of the CME can accelerate these protons in our direction—hence the proton storm.

"CMEs can account for most proton storms," says Lin, but not the proton storm of 20 January.

According to theory, CMEs can't push material to Earth quickly enough. So, back to the drawing board. But if a CME didn't accelerate the protons, what did?

"We have an important clue," says Lin. When the explosion occurred, sunspot 720 was located at a special place on the Sun: 60 degrees west longitude. This means "the sunspot was magnetically connected to Earth".

He explains that the Sun's magnetic field spirals out into the solar system like water from a lawn sprinkler. (Why? The Sun spins like a lawn sprinkler does.) The magnetic field emerging from solar longitude 60 degrees W bends around and intersects Earth. Protons are guided by magnetic force fields, so on 20 January there was a superhighway for protons leading all the way from sunspot 720 to our planet.

"That's how the protons got here," speculates Lin.

How they were accelerated, however, remains a mystery.

(Source: NASA, 10 June 2005, http://science.nasa.gov/headlines/y2005/10jun_newstorm.htm)

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A common mistake made by critics of the electric model is to assume that the radial electric field of the Sun should be not only measurable but also strong enough to accelerate electrons toward the Sun at "relativistic" speeds (up to 300,000 kilometres per second). By this argument, we should find electrons not only zipping past our instruments but also creating dramatic displays in the Earth's night sky.

But as noted above, in the plasma glow discharge model the interplanetary electric field will be extremely weak. No instrument placed in space could measure the radial voltage differential across a few tens of metres, any more than it could measure the solar wind acceleration over a few tens of metres.

But we *can* observe the solar wind acceleration over tens of millions of kilometres, confirming that the electric field of the Sun, though imperceptible in terms of volts per metre, is sufficient to sustain a powerful drift current across interplanetary space. Given the massive volume of this space, the implied current is quite sufficient to power the Sun.

Look for more details on the drift current, solar magnetic fields, nuclear reactions and many other features of the Sun in upcoming Pictures of the Day at http://www.thunderbolts.info. ∞

Additional Reading

See also these Pictures of the Day:
- Arc Lamp in the Sky
http://www.thunderbolts.info/tpod/2004/arch/040729solar.htm
- Stellar Nurseries
http://www.thunderbolts.info/tpod/2004/arch/040727stellar-nurseries.htm
- Electric Stars
http://www.thunderbolts.info/tpod/2004/arch/040922electric-stars.htm
- The Iron Sun
http://www.thunderbolts.info/tpod/2004/arch/041006iron-sun.htm
- Solar Tornadoes
http://www.thunderbolts.info/tpod/2004/arch/041015solar-tornado.htm
- Kepler Supernova Remnant
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